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MONTANA ENERGY CONSERVATION PLAN

Working Paper No. 4

ENERGY CONSERVATION IN TRANSPORTATION

A Report to the

Montana Energy Advisory Council

By

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Butte, Montana

February 1977

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TRANSPORTATION

Transportation presently accounts for about 25 percent of the nation's direct fuel consumption. An additional 18 percent of the U. S. energy budget is used indirectly to build and maintain vehicles, construct roads, etc.[11]

In contrast, Montana's transportation sector directly used 31 percent of the total energy consumed in the state in 1974. The use of motor gasoline in Montana has grown fairly steadily at an average annual growth rate of about 3 percent since 1950.[14] The majority of the gasoline consumed in Montana in 1974 was produced at in-state refineries, but only 16 percent of the feedstock for Montana refineries was produced in Montana. Forty percent of the feedstock for Montana refineries currently is imported from Canada. This feedstock is scheduled to be eliminated in the 1980's, and replacement feedstocks have not been located yet. Gasoline consumption accounts for 73 percent of the energy used in the transportation sector, highway diesel fuel accounts for 9 percent, and the remaining 18 percent is used by railroads.

The most effective near-term conservation strategy is a major fuel price increase.[7] As this currently is unpallatable to Montanans, the next most immediate savings in transportation could be made by purchasing lighter-weight, more efficient automobiles.[7] This will have to be expressed by the individual through consumer preference. The state of Montana, through the purchasing of smaller, lighter cars for its motor pool, should set a precedent in this direction. Purchases should reflect other energy savings such as automobiles with standard transmissions and

radial tires. The state should promote car and van pooling among state employees by providing preferential parking and other incentives.

In general, there are three basic modes for energy conservation; 1) reduce the demand for motor fuels; 2) increase the efficiency of vehicles; and 3) increase the number of persons per vehicle. The following options address these various modes. The first two are those program measures mandated by the Federal Energy Administration Guidelines: "Right Turn on Red" and "Car Pool/Van Pool: Increase in Transit Level of Service." Additional program measures are included.

PROGRAM MEASURE: RIGHT TURN ON RED

Narrative Statement

Montana has a "right-turn-on-red" traffic law (RCM 32-2137):

> Vehicular traffic facing the signal shall stop before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection and shall remain standing until green or "Go" is shown alone or until a right turn can safely be made and in making such turn vehicular traffic must yield the right-of-way to pedestrians lawfully within the crosswalk and to other traffic lawfully using the intersection. If a traffic sign legend indicating that no right turn on red may be made after a stop is posted at said intersection, such movement cannot be made until green or "Go" is shown alone.

Because Montana has a "right turn on red" traffic law, estimates of milestones, energy savings, and implementation cost are not applicable.

PROGRAM MEASURE: CAR POOL/VAN POOL: INCREASE IN TRANSIT LEVEL OF SERVICE

Narrative Statement

The transportation sector in Montana offers considerable prospect for energy savings because of the high percentage of total energy use it constitutes. At the same time, it must be remembered that reduction in fuel use is quite difficult in a highly rural state where transportation is a critical link between dispersed pockets of population. The greatest opportunity for savings in the mandated program measures in transportation lies in the more urbanized areas where incentives are necessary to increase the number of persons per vehicle. In response to FEA requirements, two Montana cities with urban area populations of between 50,000 and 100,000 have been selected for car pool/van pool matching campaigns (Billings) and increased levels of transit service (Billings and Missoula).

Both carpooling and increased levels of transit service can produce direct energy savings with residual benefits of reduced peak hour traffic congestion, air pollution, and transportation for the aged or disabled. Habits associated with the use of private automobiles are difficult to break and may require time to alter. The program measures described here would be most effective under conditions in which complementary measures (such as increased motor fuel taxes or increased parking fees) were imposed. Nonetheless, it is possible to show net energy savings from car pooling and mass transit if imaginative and aggressive promotional programs are implemented. Four additional Montana urban areas have submitted demonstration project responses to the Federal Urban Mass Transit Act (UMTA). The Glendive Chamber of Commerce is operating a carpool matching service for persons traveling from Glendive to nearby

communities (see Appendix A). Such voluntary car pooling efforts indicate the potential for energy gains from broadening these programs.

A plan exists for implementing a car pool system for Billings which only requires sufficient funding to be in place by January 1, 1978.[13] Funds to support the program have been proposed in the Emergency Highway Energy Conservation Act, available initially to the communities on a 90/10 federal/state match basis.

The plan for increasing the transit level of service in Billings calls for significant increases in service and ridership including a reduction of headway time from 45 minutes to 20 minutes.[18] The increased level of service is dependent upon the purchase of new buses. A bill in the current legislative session would provide state matching of capital grant funds under UMTA for purchase of equipment by local governments. Upon receipt of funding, this program could be in operation within one year and fully implemented by 1980.

Voters in Missoula approved creation of a metropolitan transit district to provide service within the incorporated area. The plan provides for establishment of a core system in 1977 and expansion in subsequent years (through 1980). The savings attributable to this initiation of transit service are comparable to the increase expected in upgrading the Billings program. Both the Billings and Missoula expanded transit level of service programs are coordinated through their respective local metropolitan planning organizations.

Estimated Energy Savings for Calendar Year 1980

Billings Car Pool

Assuming that 10 percent of the working force participates, the system would result in a reduction of 12, 836 vehicle miles of travel per day in Billings which amounts to 237,120 gal/yr or .02964 x 10^{12} Btu/yr. Applying the annual growth rate in gasoline consumption of 3 percent (reflecting both the increased numbers of miles driven and participation in the car pool program), the system would give a total savings of .0353 x 10^{12} Btu. Because of the estimated small savings, the "Guidelines for Travel Demand Analysis of Program Measures to Promote Carpools, Vanpools, and Public Transportation," prepared for the Federal Energy Administration by Cambridge Systematics, Incorporated, was not used to calculate the potential energy savings. The city of Billings conducted a comprehensive car pooling analysis which is used for this analysis.[13]

Billings chose to use the FHWA Computer Matching Program to match travel data and participant requests. There are approximately 42,800 employees in the Billings urban area. The average roundtrip to work is 6 miles. The following assumptions were used to calculate the energy savings:

a. 1.2 commuters per vehicle in rush hours;

b. 10 percent of total employees join car pool;

c. 13 miles per gallon of fuel consumed;

d. 3 commuters per vehicle in car pool; and

e. 98 percent of the employees in cars.

For detailed calculations, refer to carpool plan and calculations in Appendix B.

Billings Mass Transit

Two methods were used to project the possible energy savings of this program measure: "Guidelines for Travel Demand Analysis of Program Measures to Promote Carpools, Vanpools, and Public Transportation" and Btu analysis from data provided by the Billings transportation planners. The first procedure would yield a savings of $.061 \times 10^{12}$ Btu/yr, whereas the latter method projects a savings of $.00673 \times 10^{12}$ Btu/yr. The latter number is in the same magnitude as that calculated for the Missoula bus system and is the more conservative figure. Thus, the remaining analysis is based on this projection.

Only the persons served by the bus route were included in the analysis. This included 87,000 persons served with an average of 2.7 persons per household. Assume that 1.1 workers per household yields 35,444 potentially affected workers.[18] The remaining assumptions were used in calculating with FEA guidelines:

a) 1.2 persons per car;

b) 6 mile roundtrip;

c) 13 miles per gallon per auto;

d) 8 miles per gallon per diesel bus;[18]

e) 40 persons per bus and 20 percent occupancy; and[9]

f) base modal shares (see Appendix C).[18]

Methodology used to calculate savings from information provided by the Billings city transportation planner included the following:

a) total ridership per day would increase from 1500 in 1975 to 2100 in 1980;
b) the number of bus miles traveled per day to decrease headway would increase from 1500 miles per day in 1975 to 2000 miles per day in 1980:
c) 6 mile roundtrip;
d) 13 miles per gallon per auto; and
e) 8 miles per gallon per diesel bus (see Appendix D).

Missoula Mass Transit

Based on data provided by the Missoula City Planning Office, the bus system to be implemented by 1980 would have an energy savings of $.0065 \times 10^{12}$ Btu/yr. Translated into gallons of gasoline, the system would yield a savings of 51,864 gallons of gasoline.

Figures provided by the Missoula City Planning Office on the number of bus miles traveled per year and the number of persons riding the bus system formed the basis on which the energy savings was computed (see Appendix E). Assumptions included the following:

a) 447,668 miles traveled per year by bus in 1977;
b) 24,700 persons used the bus per year in 1977;

c) the ridership and bus mileage remained constant through 1980;

d) 13 miles per gallon per auto; and

e) 8 miles per gallon per diesel bus.[18]

Note the total savings is .048 trillion Btu's in 1980.

Table I.--Costs of Implementation

	Billings Car Pool	Billings Mass Transit	Missoula Mass Transit
1977	$26,000		$1.2 million (capital costs only)
1978	6,000	$200,000	
1979	6,000		
1980	6,000		

PROGRAM MEASURE: PUBLIC TRANSPORTATION AND RAILROAD ASSISTANCE FUND

Narrative Statement

The energy efficiency of well utilized public transportation and railroad passenger and freight service offers prospects of substantial energy savings if a significant portion of transit needs now met by private automobiles and motor freight carriers could be assumed by the urban public and railroad transportation modes. Large shifts to these efficient alternatives from the private internal combustion vehicle are unlikely in view of the totally inadequate level of service and convenience currently offered by these transportation systems.

Years of neglect and under-utilization of these systems have been aggravated by the public subsidy of the interstate, state, and local highway system and related services such as police patrol, traffic control systems, and public parking facilities. There has been a pervasive presumption that the public interest is best served by government actions which increase the speed, accessibility, geographic range, and convenience of private automobile and truck transportation. This preoccupation with private on-demand mobility has seriously impaired the capability of other transit modes to support Montana's transportation requirements. Because of the single focus policy, Montana's economic health and social diversity lean upon an energy supply which is extremely vulnerable to curtailments and disruptions over which the state has little or no control.

To reestablish a balanced and diverse transportation system, Montana must be willing to invest significant capital and operational expenses to support its rail system and urban transit system. Public response to these transportation improvements are likely to be slow as engrained attitudes regarding cars (their convenience, economic margin, and speed) adjust to emerging fuel constraints and price inflation.[11] Deficit operation of many public transit and rail services is to be expected during the beginning years of establishing public confidence in, and use of, these systems. Without assuming the responsibility for providing energy efficient transportation alternatives now, Montana cannot expect to be spared the consequences which will beset a society whose mobility is almost totally dependent on the fluctuations of foreign suppliers of petroleum.

In view of this need for immediate preparation of a multipurpose transportation system, we recommend that the Gasoline Distributor's License Tax (levied at 7 3/4¢/gallon effective July 1, 1977) be increased by 2 1/4¢/gallon, with the revenues being deposited to the account of a Public Transportation and Railroad Assistance Trust Fund. The monies in this fund would be administered by the state's Department of Community Affairs, which currently has authority for public transit programs and is to be designated the lead agency for Montana's railroad planning and assistance program. Eligible appropriations from this trust fund would be for 1) state grants to local governments for public transit planning; 2) state capital grants to local governments to match federal Urban Mass Transportation Act funds (80/20 federal to state and local matching ratio) for public transit vehicles, equipment, and facilities; 3) state subsidies for up to one-half of a local public transportation program's operational deficits (as currently authorized by 11-4513 RCM); 4) state planning, subsidization, and capitalized implementation of a statewide rail service program as developed in compliance with the federal Railroad Revitalization and Regulatory Reform Act; 5) state grants for planning, capitalized implementation, and operational support of innovative, energy efficient transportation demonstration projects; and 6) expenses incurred by the department for planning, implementing, and evaluating the statewide public and railroad transportation programs.

The fund would receive approximately 19 million dollars (2 1/4¢/gal x 422,233,150 gals/yr) from revenue generated in the 1978-1979 biennium if the tax were to go into effect by July 1, 1977. While these

are not insignificant sums of money, they are a modest proportion of the funds allocated to the Highway Trust Fund (approximately $65,446,200). It also must be recognized that there is a pressing need for state financial assistance to public transit and railroad service maintenance at this very moment.

Perhaps more than one hundred miles of railroad lines within Montana have been abandoned in the last few years. An application for abandonment of a forty-three mile stretch of rail service between Vaughn and Augusta (Lewis and Clark and Cascade counties) has been requested this year.[20] There also is the prospect of the Milwaukee Railroad Company merging with Burlington Northern (Milwaukee's petition for permission to merge currently is before the Interstate Commerce Commission). Under federal railroad reorganization rules, merged railroad companies can discontinue rail service along one of their combined lines whenever they are roughly parallel. Since most, if not all, of Milwaukee's rail lines are in this parallel category with Burlington Northern's service, the potential impact of discontinued rail service throughout the southern portion of Montana is severe.

A large portion of rail freight demand comes from Montana farmers who must move millions of bushels of grain and other products to markets each year. When rail haulage of this harvest is curtailed or discontinued, farmers have little option but to switch to motor freight carriers. Not only are motor carriers less energy efficient than rail

freight, the increased requirements and wear and tear of rural road systems would require substantial expenditures of state highway trust funds to upgrade roadways for this increased motor carrier use.

Maintenance and eventual expansion of rail freight service in eastern Montana is particularly significant if the state is to pursue a policy of exporting coal for out-of-state energy demands. Sustaining and extending local rail service may be desirable if Montana chooses to encourage in-state small scale load center coal conversion to electricity, district heating, and residential heating. Transporting coal for industrial co-generation and local utility service would be assisted greatly by a functional rail system.

The case for assistance to urban public transit programs also is strong for the 1978-1979 biennium. The city of Missoula recently established an urban transit district and now is purchasing buses to begin implementing its public transportation plan. The consolidated local government of Butte-Silver Bow is considering seriously the establishment of an urban transit district, and Billings needs to improve its public bus service. Currently, all capital expenditures necessary to begin such public transit programs (and to acquire 4 to 1 federal UMTA matching funds) must come from the local governments. With the full weight of capitalized expenditure upon local communities, the capability of beginning with an adequate level of public transit service is weakened.

Furthermore, while the state is authorized to subsidize up to one-half the local public transit operational deficits, the actual assistance

levels have been substantially less than this upper limit. There also is a problem of state payments coming at the end of the year in which the deficits occured, while the local government must cover the costs on a continuing basis. We endorse the Department of Community Affairs' recommendation that the state provide operational funding assistance at the beginning of the year based on estimated deficits or during the year as deficits are incurred (perhaps on a quarterly basis).

Estimated Energy Savings for Calendar Year 1980

Energy savings under this program measure will occur from both reduced demand due to increased gasoline prices and from the direct energy savings from increased levels of public transportation and other innovative transportation measures.

It has been documented that an increase in the price of gasoline will cause a decrease in its demand. Assuming a "best case" estimate, a 1 cent increase in gasoline price would give a 1 percent fuel savings in 1980.[7] Using a 3 percent annual growth rate in gasoline consumption,[14] 1980 gasoline consumption is projected to be 66.8 trillion Btu's. Thus, it is estimated that 1.5×10^{12} Btu's would be saved in 1980 by the enactment of this indirect measure (Appendix F). The direct energy savings accompanying this measure cannot be quantified at this time. All the specific programs that would be adopted have not been enumerated yet.

As one specific example of the potential direct energy savings from this program, we shall consider the Vaughn to Augusta rail line. Approximately 2,557 tons of agricultural or livestock products were hauled over this line in 1972.[20] If this transportation is done by truck with an energy use of 2,400 Btu/ton mile,[5] the energy usage would be 2.639×10^8 Btu. If the same load was hauled by train with an energy use of 750 Btu/ton mile,[5] the energy demand would be 8.246×10^7 Btu. If the level of production remained constant, the projected savings in 1980 would be .00018 trillion Btu's (Appendix G).

Table II.--Costs of Implementation

	Administrative Costs	Additional Tax
1977	$12,500	$4.75 million
1978	25,500	9.5 million
1979	50,000	9.5 million
1980	50,000	9.5 million

PROGRAM MEASURE: BIKEWAY CONSTRUCTION

Narrative Statement

As with many other energy conservation program measures, the promotion of bikeways has a dual set of benefits. Not only is bicycling an enerrgy efficient mode of transportation, it is less expensive, often more convenient, usually more healthful, and certainly more compatible environmentally than its chief rival--automobiling. Based on testimony in public hearings throughout Montana's urban areas, if bicycle paths were established to help reduce the hazards of competing with other traffic, a

significantly greater incidence of bycycling would occur. Immediate goals in Montana are to develop the bikeways in four of the larger urban areas: Miles City, Missoula, Billings, and Great Falls. Funding would come from state highway construction funds if the legislature clarifies previous legislation providing for 3/4 of 1 percent of the funds to be spent for creation of footpaths and bicycle trails.

Estimated Energy Savings for Calendar Year 1980

Extensive local energy saving calculations have been performed for potential bikeways in Miles City, Billings, Great Falls, and Missoula. The combined plans are projected to result in over 163,000 fewer vehicle miles per day traveled in these cities. Based on the overall routes and a maximum roundtrip of six miles, 40% of all auto trips may be potentially suitable for bicycles, based on the assumption that 2% of all auto trips are converted to bicycle trips. The total savings from implementing bikeways in these four cities is estimated at .0032 trillion Btu's (Appendix I).

Table III.--Costs of Implementation*

	Miles City	Missoula	Billings	Great Falls
1977-1980	$26,800	$117,000 (in hand)	$166,400	$67,440

*To be funded from a combination of gasoline tax, bicycle license fees, sale of maps, federal grants from Bureau of Outdoor Recreation, and Highway Safety funds.

PROGRAM MEASURE: ENFORCEMENT OF 55 M.P.H. SPEED LIMIT

Narrative Statement

Numerous studies have well documented the two-fold advantage of the nationwide 55 mile per hour speed limit: overall fuel savings and reduction

of accidents. Nonetheless, it remains true that penalties for violation have failed to produce uniform compliance with the speed standard. In Montana, a combination of extensive open road and inconsequential fines has produced a substantial percentage of violators. Based on 1976 Montana Highway Patrol data, more than 60 percent of drivers on state highways exceeded the limit (broken down as follows):

31.8 percent	55-60 m.p.h.
19 percent	61-65 m.p.h.
7.7 percent	66-70 m.p.h.
3.8 percent	70+ m.p.h.

Strict enforcement of the 55 m.p.h. limit could produce significant savings by 1980. It has been shown that automobiles traveling at 60 m.p.h. consume 5 percent more fuel per mile than those traveling at 55 m.p.h. The corresponding figures for reductions back to 55 m.p.h. are 13 percent for 65 m.p.h. and 20 percent for 70 m.p.h. Thus, immediate savings are likely since more than half of Montana's drivers would be affected. It should be noted that stricter enforcement of the limit may alter the behavioral pattern of only a portion of the drivers (perhaps two thirds) and that resentment to the imposition may produce some non-quantifiable costs of compliance. A strict enforcement program should focus first upon greater voluntary compliance, especially during the portion of the year when the nation's fuel shortages are dramatized by the winter's cold.

Immediate enforcement with stricter fines will not require any additional manpower, vehicles, or radar costs on the part of the Montana Highway Patrol. The exact fine mechanism and structure will be determined by the 1977 Montana State Legislature.

Estimated Energy Savings for Calendar Year 1980

Approximately 75 percent of the vehicle miles traveled in Montana are on roads with a posted 55 m.p.h. speed limit. Using data supplied by the Montana Highway Department and the Montana Highway Patrol, we calculate that if everyone in the state obeyed the 55 m.p.h. speed limit, 2.83 percent of the energy used in transportation could be saved. In our analysis, we assume that strict enforcement of the 55 m.p.h. speed limit would cause two thirds of the drivers in Montana to change their behavior and obey the speed limit. This would result in a 1980 projected energy savings of 2.23 trillion Btu's (Appendix H).

Table IV.--Costs of Implementation*

1977	0
1978	0
1979	0
1980	0

*This is based on tying fine structure to increased costs of surveillance and processing; indirect costs are not calculated.

TRANSPORTATION: NON-PROGRAM MEASURES

1. Shift to Lighter Cars

If weight reductions were implemented by manufactures and purchased by consumers in the near future, it is projected that a 10% savings of annual gasoline usage could be achieved by 1980 on a national basis.[7] To achieve this would require the imposition of weight, technology or fuel economy standards on automobile manufacturers. By the late 1980's, weight reduction

and technology changes implemented in the late 1970's are projected to save up to 40% of present fuel usage.[7]

Lighter weight vehicles would generally have lower initial and operating costs. With greater mileage efficiency and lower costs, there would be inducements for greater vehicle miles traveled, but not enough to offset the large gain in energy efficiency. An increase in vehicle miles traveled (VMT) would cause an increase in employment in the service and parts sectors. Increased VMT would cause an increase in emissions, but these again would not offset the reduction of emissions caused by greater miles per gallon (mpg) performance.

A graduated tax to discourage the purchases of less efficient autos has been suggested as a means to stimulate the market for vehicles with high mpg performance. A recent study suggests that such a tax would offer little promise in the near term, for households will generally operate their autos longer, thus retaining older, less efficient vehicles in the auto fleet for longer periods of time.[7] A fixed or graduated ownership tax on used cars as well as new cars would tend to mitigate these impacts.

In a recent survey conducted by Author D. Little, persons were asked how a graduated tax on new cars, based on three size differences (representing mpg performance), would affect their purchasing. If a 10% tax was imposed on large cars and a 7% tax was imposed on medium cars in 1980, only 2.8% of current large-car owners would purchase a smaller vehicle, and only 8.3% of large-car owners would purchase medium weight vehicles. Thus, the demand for the large luxury vehicle may be inelastic relative to price increases.

Graduated Speed Limit

A more sensitive, positive incentive to stimulate purchasing vehicles with high mpg performance may be preferential speed limits. With wide expanses of land to traverse in Montana, travel time is of extreme importance. The 55 mph mandatory speed limit has been particularly ill-received in the dispersed eastern part of the state. It is proposed that vehicles obtaining specific gas mileage be allowed to drive at varied maximum speeds. For instance, cars averaging over 35 mpg would be allowed to travel up to 65 mph; cars averaging 25-35 mpg would be allowed to travel up to 60 mph; cars averaging 15-25 mpg would be allowed to travel up to 55 mph; and those cars averaging less than 15 mpg would not be allowed to exceed 50 mph.

There is substantial justification in this proposal based on calculations of aerodynamic drag and rolling resistance. A vehicle with a drag coefficient of .3 can achieve better gas mileage at 65 mph than an automobile with a higher drag coefficient at 55 mph.[16] The smaller lightweight vehicles have greater capacity in design for lowered drag coefficient than do the large cumbersome vehicles. A 5,000 lb vehicle requires nearly double the horsepower to combat rolling resistance as that required for a 2,000 lb-car, irregardless of speed. Thus, although a lightweight, well-designed vehicle will get better gas mileage at 55 mph than at 65 mph, it will get better mileage at 65 mph than the large, heavy vehicle at 55 mph.

As a step toward more efficient vehicles, the preferential speed limit illuminates on an important aspect of human behavior. Most people want to drive faster. Time is precious. If an individual driving a

large energy guzzler is constrained to drive at 50 mph under penalty of stiff fines while a tightly designed, lightweight vehicle cruises by at 65 mph, the former individual will be frustrated. The negative reinforcement of constrainment likely will be sufficient motivation to make his next car purchase reflect its mileage performance.

There is no doubt that there will be an increased imposition on the state highway patrol to administer such a system. This could be ameliorated by each vehicle with specified vehicle performance having a varied sticker or coded license plate. Opposition from highway safety boards may occur. It should be noted, however, that over 60% of Montana drivers currently surpass the 55 mph speed limit. As a safety precaution, we advise that all vehicles receiving the over 55 mph preferential speed limit be equipped with air bag safety belts. Similar preferential treatment could be given to subcompact model vehicles with 4 to 5 passengers.

Senate Bill 193--1977

SB 193 introduced into this legislative session requests a vehicle fee based on vehicle age, eliminating the current property tax based on blue book value. The result of SB 193 would be that new light weight, efficient vehicles would be taxed as high as expensive, energy-consuming luxury cars.

An assessment on vehicles should reflect their prudent or abundant use of non-renewable resources. An effective measure of a vehicle's energy consumption is its weight. Under typical operating conditions the energy per passenger mile for two weights of vehicle is:[9]

4.6 thousand Btu	8.9 thousand Btu
2,000 lb. vehicle	3,100 lb. vehicle

Consequently, MERDI has drafted an energy conservation amendment to SB 193 basing the fee on a combination of vehicle weight and age.

2. Traffic Flow

There are several suggestions in need of further examination concerning how regulating traffic flow could decrease energy use. Synchronization of traffic lights within cities so that through traffic can maintain a 40 mph traffic flow would achieve optimal fuel economy. Shifting to staggered work hours in urban areas would reduce the intensity and peak loads of rush hour traffic thereby reducing traffic congestion and reducing energy consumption. A four-day work week is now being discussed at the national level. Such a program would reduce the number of work trips by 20% and could reduce peak transportation demands in conjunction with staggered schedules.

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APPENDIX

Glendive Area Chamber of Commerce
and Agriculture

P. O. Box 930 : Phone (406) 365-5601

Glendive, Montana 59330

January 25, 1977

Dear Chamber Executive:

The Glendive Area Chamber of Commerce and Agriculture has originated a timely and very vital energy conservation program, which we wish to share with you.

The program, "SHARE-A-RIDE", became effective in the Glendive area on Tuesday, January 18 and was presented for the first time during the Chamber Report on KXGN-TV that evening. Response to the announcement was immediate.

The safety aspect speaks for itself. By instigating "SHARE-A-RIDE" in your area, the local Chamber would be directly effective in reducing the number of cars now traveling the Interstate and secondary roads, which in turn would drastically cut the fuel consumption and could make a sizeable dent in the "energy crunch".

"SHARE-A-RIDE" will also affect the 'ol pocket book——in a POSITIVE way! By sharing the travel costs and reducing one person/one car expenditures, everybody profits, and in these days of escalating inflation, each of us should be responsible for pursuing and supporting any means of curtailing expenses. This responsibility is extremely important where City/County, State and Federal Motor pools are involved.

Statistically, transportation in Montana consumes 31% of the total energy structure as compared to an 18% residential and 2% Agriculture use factor. These figures alone affirm the need and feasability of the "SHARE-A-RIDE" program.

The mileage area now covered by "SHARE-A-RIDE" extends from Helena, Mt. to Fargo, N.D. The Glendive Chamber of Commerce is now a coordinating agency and acts in the following capacity:

Mr. X calls our office and tells us he's going to Bozeman on Feb. 9 and returning Feb. 11. We record his name and phone number in a book especially reserved for this purpose. Later that day Mr. Y contacts us to say he needs a ride to Billings and we give him the information provided by Mr. X and suggest to Mr. Y that he call and make the necessary arrangements. We DO NOT make the arrangements personally, but act only as a coordinator. There is no charge for this service and it provides the community with a focal point for discussion and action concerning energy conservation.

We would encourage you to start a similar program and will appreciate your full consideration of this letter and welcome your comments and suggestions.

Sincerely,

Fran Martes

Fran Martes, President
Glendive Area Chamber of Commerce
and Agriculture

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

CITY OF BILLINGS

DEPARTMENT OF ENGINEERING

KEN HAAG, P.E., CITY ENGINEER

ELDON J. ICKES, P.E.
Assistant City Engineer

NORMAN K. GUTCHER, P.E.
City Traffic Engineer

P. O. Box 1178 Billings, Montana 59103 Phone 406-248-7511

November 12, 1976

Susan Brown
c/o Montana Energy
MHD Research and Development Institute
P.O. Box 3809
Butte, Montana 59701

Dear Ms. Brown:

Attached is the copy of the prospectus for car pooling for the City of Billings as you requested.

The project is at the point where the data input forms and grid maps have been developed and are ready for the printer. Advertising brochures can be located on short notice and we are in a hold status pending a recurrence of the fuel crisis.

If additional information is desired, please let me know.

Sincerely,

Norman K. Gutcher

Norman K. Gutcher, P.E.
City Traffic Engineer

NKG/do

P R O S P E C T U S

CARPOOLING

For

THE CITY OF BILLINGS, MONTANA

1974

CARPOOLING TECHNICAL PROPOSAL

INTRODUCTION

This proposal outlines a carpooling program for the Billings Urban area. Both national and local interests will be served by the provisions of this program since it will significantly reduce traffic congestion and energy consumption.

The conservation of energy has been the focal point of everyone's attention in recent months. Carpooling is a viable solution to this problem, while having the residual benefit of reducing traffic congestion and delays experienced by motorists during the peak traffic or "rush hours".

Based on national averages, the cost of a typical 10 mile work trip by car to downtown area is $2.64.[1] This expense can be greatly reduced by carpooling. When four riders share the expense of the same 10 mile work trip, the cost is 66¢ per person. If six riders share the cost, it becomes 44¢ per person. The cost of a similar bus trip is estimated to be 86¢. This means that the automobile, when shared by four or more commuters, is the most economical form of public transportation.

An effective and comprehensive carpool program requires an information service capable of matching the commuters' travel needs. This service would enable commuters to establish, among themselves, more economical transportation arrangements by providing a list of potential carpoolers sharing the same travel desires. This proposal describes the information service to be provided the citizens of Billings, how such a service would function, the expected benefits to be derived, and the expected costs to implement and maintain the service.

The urgency of implementing a single carpool program in the very near future is emphasized. It is highly desirable to have a coordinated program

[1] Highway Users Federation for Safety and Mobility, "Carpools and Buses", 1776 Massachusetts Avenue, N.W., Washington, D. C. 20036, Page 3.

for the entire Urban area to provide the greatest number of possible "matches" available to the commuters. Without a single or unified program to provide this matching service, individual effort by various businesses, civic groups, associations, etcetera will result in many similar but imcompatible carpooling programs. This approach, although well intended, would not serve all members of the community, nor would it provide the greatest number of possible matches for the commuters. In addition to the obvious advantages of a single program, there exists a secondary benefit from a coordinated approach to carpooling. This benefit would be derived from the data collected which will describe the travel desires of the commuters for the entire Billings area. This data would provide a valuable source of information for transportation planning which might not otherwise be available.

CARPOOLING PROGRAM

OBJECTIVES

The program is intended to encourage the use of carpools and public transit in the Billings area and, thus, increase the average automobile occupancy during the peak traffic, or "rush" hours. This increased occupancy will result in fewer vehicles using our streets and roadways, with the effect being reduced congestion and improved traffic operations. With fewer vehicles there will be less vehicle miles of travel and, consequently a savings of fuel.

DESCRIPTION

The carpooling program is best described by three (3) phases. The first or initial pase is the "Preparation Phase", the second is the "Implementation Phase", and the third is the "Continuation or Maintenance Phase" of the program.

The full implementation of the program is based on two assumptions.

1. There would be little or no interest in the program if fuel supplies in the Billings area remain at current levels.
2. Shortages will occur in the near future either from nationwide redistribution or mandatory rationing.

The work to be done under each phase is generally as follows: Phase I is the preparation phase. Based on the assumption stated above, the FHWA Computer Matching Program will be adopted to the Department of Highways computer in Helena. In so doing, the Department of Highways will also develop the format for the input.

The public information material will be developed to a point that it is ready for publication. The necessary input forms will be prepared to the same point. This work may be done at either the state or local level. This portion of Phase I will see the program ready for implementation in the event of realizations of a serious fuel shortage.

The Billings Urban area has some sixty-nine (69) employers who have fifty (50) or more employees. This amounts to 9,090 workers or about twenty-one percent (21%) of the work force which could be reached through the first channel (management) providing that contact was made and the program implemented by firms having fifty (50) or more employees. The final portion of Phase I will be to contact each of these major employers to advise them of the service to be available in event of a fuel crisis in the Billings area.

Phase II implementation requires the remaining 79% or 33,720 employees being informed of the carpool program through their employers via local civic groups and through the news media. Literature describing the program and the necessary form to be completed by the potential carpooler will be made available to the various civic clubs and others who wish to assist in the distribution

of such material. In addition, a telephone service will be provided by the city for those persons wishing to join the carpool program. This service will not actually obtain travel data from the caller but will take his name and address for mailing the necessary material.

Travel desire data will be obtained from the commuters wishing to participate in the program. This data will be recorded by the individual on a form and will include their name, social security number, address, telephone number, place of employment, the time of day that they wish to ride in a carpool, willingness to use public transportation, and why they do not use public transportation now. Informational forms received from interested carpoolers will be processed by the Montana Department of Highways.

The Montana Department of Highways computer shall be used in the "matching" process and for storing the data furnished by the program's participants. Each individual will receive a list from the City of potential carpoolers from which he may choose. The actual number of possible riders or carpoolers furnished on the list will depend upon the number of participants in the individual's home area who share similar travel desires as to the times of day and destination. It should be noted that it is the individual participant's responsibility to actually organize the carpool. The carpool program will furnish only a list of potential or possible carpoolers which share similar travel desires to and from the same geographical location. Provision will be made for the individual to exclude his name from future carpool lists at any time. This exclusion will be done at the participant's request either by telephone or by mailing a form to the city. Likewise, if an individual for some reason wishes to have their name reinstated for possible carpool matches, he may do so by telephone or by mail. Once an individual has joined the program, the data which he furnished initially, or was later altered by him, will be maintained on a permanent file. In addition to being the basis for

the carpool program, this information will also be used in the future by transportation planners for the Billings urban area. Such planning may include the determination of the most desirable bus transit routing or the best location for parking lots.

Phase III is the surveillance and evaluation phase. Effectiveness of the program will be measured in terms of the number of carpools formed and by vehicle occupancy rate checks. At such time that the individual requests his name to be deleted from future carpool lists, he will be asked if he has joined a carpool and, if so, how many commuters share the automobile. From this information the change in vehicle occupancy and corresponding reduction in vehicle-miles-traveled which results from the carpooling program can be computed for the Billings urban area.

The implementation phase of the carpool program will necessitate the greatest expenditure of time and resources. After the initial data collection and processing, the continuation or maintenance of the program will be a relatively easy task. The actual work involved with maintaining the carpool program will depend upon the area's yearly change of employment, the initial number of program participants, and the future popularity of carpooling.

BENEFITS

As described herein, the carpool program has the potential of significantly reducing the number of vehicle-miles traveled in the Billings urban area. Any reduction in the VMT, as previously mentioned, will result in less traffic congestion and reduced fuel or energy consumption.

It has been conservatively estimated that the carpool program, if only 10% of the working force participates, could result in a reduction of approximately 12,836 vehicle miles of travel per day in the Billings

area (see Appendix A). This change in vehicular travel amounts to a savings of 988 gallons in gasoline per day which totals approximately $492.00. These figures are based on an average of 13 miles per gallon of gasoline at a cost of 49.9¢ per gallon.

Another approach to assigning a dollars and cents figure to the benefits derived from the carpool program is to use the commonly accepted vehicle operating cost of 12¢ per mile. Such an approach would indicate a daily savings of approximately $1,540.00 to the community.

No attempt has been made to assign a dollar value to the time savings which would be experienced by the commuters going to and from work. With fewer vehicles on our roads and streets during the rush hours, traffic operations will improve resulting in less congestion and fewer delays to the carpoolers.

COSTS

The cost to implement the carpool program is estimated at $26,000 for the first year (see Appendix B). This figure includes the additional staffing, equipment, printing, mailing, computer time, and advertising required by the City of Billings.

To maintain the program in subsequent years, an annual cost of $6,000 has been estimated. This cost represents the necessary staffing, equipment, printing, computer processing, and miscellaneous items required to continue the carpooling service to the community's citizens.

The City of Billings respectfully requests that monies be allocated from either the "Urban System Funds" or the "Primary and Secondary Urban Extensions" as authorized by the Emergency Highway Energy Conservation Act (approved by Congress on December 21, 1973) to finance the carpooling program described herein.

The total expenditure, $26,000, if financed by the provisions of the Emergency Highway Energy Conservation Act, would constitute a cost of $23,400 to the Federal Government and $2,600 to the State of Montana when apportioned on the 90/10 matching basis.

Subsequent financing required for the continuation of the carpool program by the City of Billings, if desired, would amount to approximately $6,000 per year. This funding would be one-hundred per cent (100%) local.

APPENDIX A

BENEFITS OF CAR POOLING
IN THE
BILLINGS URBAN AREA

Given:

42,800 employees in the Billings Urban area. 3 miles per work trip (home to work).

Assumptions

1.2 commuters per vehicle in rush hours.

10% of total employees join carpool

13 miles per gallon fuel consumption.

6 miles average work trip (home-work-home)

49.9¢ per gallon fuel cost.

3 commuters per vehicle in carpool.

98% of employees in cars.

Calculations:

Present work trips per day

42,800 employees x 0.98 = 41,944 auto commuters

41,944 ÷ 1.2 commuter/auto = 34,954 automobiles

34,954 x 6 mile per trip = 209,720 automobiles

Present fuel consumption & cost per day

209,720 veh. miles÷13 mi/gal. = 16,133 gallons

16,133 x 49.9¢ = $8,050/day

Work Trips with Carpooling

42,800 x 10%	=	4,280 commuters in carpools
4,280 ÷ 1.2	=	3,567 autos previously used by commuters
4,280 ÷ 3	=	1,427 autos eliminated by carpooling
3,567 - 1,427	=	2,140 autos eliminated by carpooling
34,954 -2,140	=	32,814 autos now used commuting
32,814 x 6	=	196,884 vehicle miles

Fuel Consumption & Cost Per Day with Carpooling

196,884 miles	÷	13 mi/gal.	=	15,145 gallons/day
15,145 x 49.9¢/gal.			=	$7,558/day

Projected Savings by Implementing Carpooling

a. vehicle miles: 209,720 minus 196,884 = 12,836 vehicle miles

b. gasoline: 16,133 minus 15,145 = 988 gallons

c. dollars for fuel: $8,050 minus $7,558 = $492/day

d. operating cost of vehicles @ 12¢/mile:

12,836 miles x $0.12/mi. = $1,540/day.

APPENDIX B

Implementation Program Annual Cost

Personnel, Part Time Only	$ 7,300.00
Equipment Costs	700.00
Printing Costs	1,000.00
Postage Costs	1,500.00
Computer Time	11,000.00
Advertising	2,000.00
Contingencies	2,500.00
	$26,000.00

Continuation Program Annual Cost

Personnel	$ 2,050.00
Equipment	200.00
Printing	300.00
Postage Costs	450.00
Computer Time	2,600.00
Advertising	400.00
	$ 6,000.00

MERDI CALCULATIONS

@10% Usage: $125{,}000 \frac{\text{Btu's}}{\text{gal.}} \times \frac{237{,}120 \text{ gal.}}{\text{yr.}} = 2.964 \times 10^{10}$ Btu/yr.

$$\frac{.02964 \times 10^{12} \text{ Btu's/yr.}}{66 \times 10^{12} \text{ Btu's/1974}} = .000449 = .0449\% \text{ of fuel used in Montana/1974 usage}$$

Assuming some 10% level of participation 1980

.0449% x 78.7 Btu's = .035 trillion Btu's = @.2% of total savings.

III. ESTIMATION OF REVISED WORK-TRIP MODAL SHARES

POLICY: _____

SUBGROUP: _____

1. CHANGE IN UTILITY FOR EACH MODE

Drive Alone

$\Delta UTILITY = [-.015] \times [\Delta IVTT_{da}] = [\quad]$

$+ [-.16] \div [\text{Trip Length}] \times [\Delta OVTT_{da}] = [\quad]$

$+ [-29.0] \div [\text{Income}] \times [\Delta OPTC_{da}] = [\quad]$

TOTAL CHANGE [ ]

Shared Ride

$\Delta UTILITY = [-.015] \times [\Delta IVTT_{sr}] = [\quad]$

$+ [-.16] \div [\text{Trip Length}] \times [\Delta OVTT_{sr}] = [\quad]$

$+ [-29.0] \div [\text{Income}] \times [\Delta OPTC_{sr}] \div [\text{Average Car-pool Size}] = [\quad]$

$+ [.29] \times [\text{Incentives}] = [\quad]$

TOTAL CHANGE [ ]

Transit

$\Delta UTILITY = [-.015] \times [IVTT_t] = [0]$

$+ [-.16] \div [\text{Trip Length}: 3] \times [OVTT_t: -25] = [+1.33]$

$+ [-29.0] \div [\text{Income}] \times [OPTC_t] = [0]$

TOTAL CHANGE [+1.33]

2. REVISED MODAL SHARE

	Base Modal Share		ΔUtility			Total		Revised Share
Drive Alone	= 71.9	× EXP	0	=	.719	÷ 1.159	=	.620
Shared Ride	= 10.6	× EXP	0	=	.106	÷ 1.159	=	.092
Transit	= 5.7	× EXP	1.33	=	.216	÷ 1.159	=	.186
Vanpool	= 1.6	× EXP	0	=	.016	÷ 1.159	=	.014
Other	= 10.2	×	1.0	=	.102	÷ 1.159	=	.088
			Total	=	1.159			

POLICY: Increase in Level of Service

Billings Public Bus System

Population Subgroup	Fraction of Total Population	Average Household Data			Base Work Trip Modal Shares				Average Carpool Size	Average Trip Length		Average Daily VMT/ [illegible]		
		Annual Income $	Number of Workers	Number of Non-Work Auto Trips	Drive Alone	Shared Ride	Transit	Other		Work (one way)	Non-Work (one way)	Work	Non-Work	Total
					Employee									
Work		13,290	1.1	6.5	71.9	10.6	5.7	11.8	2.5*	3	3.4	4.4	25.1	29.5
Non-work		13,290	1.1	6.5	57.0	10.6	8	34.5						

*National

I. BASE DATA

BILLINGS BUS SYSTEM--FEA METHODOLOGY

Assumptions:

1) Work Force: 32,222 Households x 1.1 Worker/Household = 35,444 Workers
2) Average Roundtrip (Rt) = 6 miles
3) 260 days of operation per year

Base Model Share:

Alone	Share	Transit	Carpool	Other
71.9%	12.2%	5.7%		10.2%
25,484 persons	4,324 persons	2,020 persons		3,615 persons

Gasoline:

Alone: 25,484 persons x $\frac{6 \text{ mile Rt/day}}{13 \text{ mpg}}$ = 11,762 gal x $\frac{125{,}000 \text{ Btu}}{\text{gal gasoline}}$ = $14{,}703 \times 10^5$ Btu/day

Share: 4,324 persons x $\frac{\text{car}}{1.2 \text{ persons}}$ x $\frac{6 \text{ Miles Rt/day}}{13 \text{ mpg}}$ = 1,663 gal x $\frac{125{,}000 \text{ Btu}}{\text{gal gasoline}}$ = $2{,}079 \times 10^5$ Btu/day

Diesel Transit[1]:

2,020 persons $\frac{\text{bus*}}{8 \text{ persons}}$ x $\frac{6 \text{ Miles Rt/day}}{8 \text{ mpg}}$ = 189 gal x $\frac{138{,}800 \text{ Btu}}{\text{gal diesel}}$ = 263×10^5 Btu/day

TOTAL $17{,}045 \times 10^5$ Btu/day

Revised Modal Share:

Alone	Share	Transit	Other
6.2%	10.6%	18.6%	8.8%
21,975 persons	3,757 persons	6,593 persons	3,119 persons

Gasoline:

Alone: 21,975 persons x $\frac{6 \text{ Mile Rt/day}}{13 \text{ mpg}}$ x $\frac{1 \text{ gal}}{}$ = 10,142 gal x $\frac{125{,}000 \text{ Btu}}{\text{gal gasoline}}$ = $12{,}678 \times 10^5$ Btu/day

Share: 3,757 persons x $\frac{1 \text{ car}}{1.2 \text{ persons}}$ x $\frac{6 \text{ Mile Rt}}{13 \text{ mpg}}$ = 1,445 gal x $\frac{125{,}000 \text{ Btu}}{\text{gal gasoline}}$ = $1{,}806 \times 10^5$ Btu/day

Diesel Transit:

6,593 persons x $\frac{\text{bus}}{24 \text{ persons}^2}$ x $\frac{6 \text{ Miles Rt}}{8 \text{ mpg}}$ = 206 gal x $\frac{138{,}800 \text{ Btu}}{\text{gal diesel}}$ = 286×10^5 Btu/day

TOTAL $14{,}690 \times 10^5$ Btu/day

1. 40 person/bus @ 20% occupancy (National Average)
2. 3.26 times as many persons riding transit; therefore, if at 20% occupancy in first case then 8 x 3.26 = 24 persons per bus or 60% occupancy

ENERGY SAVED

$.0017045 \times 10^{12}$ Btu/day: Base Modal Share

$.0014690 \times 10^{12}$ Btu/day: Revised Modal Share

$.0002355 \times 10^{12}$ Btu's saved/day

$= .0002355 \times 10^{12}$ Btu/day x 260 days/year $= .061 \times 10^{12}$ Btu/year

BILLINGS BUS SYSTEM--ALTERNATE METHODOLOGY

1975	1980
Total Number People Ride 1500/day	2100/day
Number Miles Traveled/day - 1500 Miles/day	2000 Miles/day
6 Miles Average Round Trip	6 Miles Average Round Trip

$$600 \text{ people} \times \frac{6 \text{ mile Rt}}{13 \text{ mpg}} = \frac{277 \text{ gal}}{\text{day}} \times \frac{1.25 \times 10^5}{\text{Btu/gal}} = \frac{346 \times 10^5 \text{ Btu}}{\text{day}} \times \frac{260 \text{ days}}{\text{year}} = 8.99 \times 10^9 \text{ Btu/year}$$

$$\frac{500 \text{ miles}}{\text{day}} \times \frac{\text{gal}}{8 \text{ miles}} = \frac{62.5 \text{ gal diesel}}{\text{day}} = 86.75 \times 10^5 \text{ Btu/day} \times \frac{260 \text{ days}}{\text{year}} = 2.26 \times 10^9 \text{ Btu/year}$$

ENERGY SAVED 8.99×10^9 Btu/year - 2.26×10^9 Btu/year = 6.73×10^9 Btu saved/year

or $.00673 \times 10^{12}$ Btu/year

$$= \frac{67300 \times 10^5 \text{ Btu/year}}{.2500 \times 10^5 \text{ Btu/gal}} = 53840 \text{ gal/year equivalent}$$

MISSOULA BUS SYSTEM

Number of Miles/Year by Bus = 447,668 Number of People/Year = 247,000

Bus Travel: $447{,}668 \frac{\text{miles}}{\text{year}} \times 8 \text{ mpg} \times 1.388 \times 10^5 \frac{\text{Btu}}{\text{gal diesel}} = 77{,}670 \times 10^5$ Btu/year for buses

Equivalent Automobile Travel: $247{,}000 \frac{\text{cars}}{\text{year}} \times \frac{6 \text{ miles Rt}}{13 \text{ mpg}} \times 1.25 \times 10^5 \frac{\text{Btu}}{\text{gal gasoline}} = 142{,}500 \times 10^5$ Btu/year for cars

ENERGY SAVED: $142{,}500 - 77{,}670 \times 10^5$ Btu/year $= 64{,}830 \times 10^5$ Btu/year saved

$= .0064830 \times 10^{12}$ Btu/year saved

$$\frac{64830 \times 10^5 \text{ Btu/yr}}{1.25 \times 10^5 \text{ Btu/gal gas}} = 51{,}864 \text{ gal gas equivalent}$$

APPENDIX F

ENERGY SAVED BY GASOLINE TAX

Assuming best case (more likely to occur by 1982)

A 1% increase in gas price gives 1% fuel saving[7] in 1980.

Tax of 2 1/4 / gallon would give gasoline savings of 2 1/4%.

Projected 1980 fuel consumption of gasoline is 66.8 trillion Btu's.

Gasoline	1974	1975	1976	1977	1978	1979	1980
	56 trillion	57.7	59.4	61.2	63.0	64.9	66.8

66.8 x .0225 = 1.503 trillion Btu's saved.

1.503×10^{12} Btu's/yr or $\frac{1.503 \times 10^{12} \text{ Btu/yr}}{1.25 \times 10^{5} \text{ Btu/gal}}$ = 12,024,000 gal. gasoline equivalent/year

This is through driving less and assuming better energy efficient driving habits.

Emissions

A 1% increase in fuel price in 1980 would cause about a 2% decrease in emissions[7] (p. 139).

Therefore, this policy would decrease emissions by about 4.5%.

APPENDIX G

FREIGHT

Based on the only requested abandonment received to date, the projected energy savings if that line is continued will be calculated.

Line: 43 miles between Vaughn and Augusta between Lewis and Cascade Counties. The latest records are for 1972.

1,627 tons wheat hauled out
728 tons cattle hauled out
42 tons sheep hauled out
160 tons fertilizer hauled in

2,557 tons hauled over 43 miles.

If all by truck at 2,400 Btu/ton mile:[5]

2,400 Btu/ton mile x 2,557 tons x 43 miles = 2.639×10^8 Btu/year

If all by rail at 750 Btu/ton mile:[5]

750 Btu/ton mile x 2,557 tons x 43 miles = 8.246×10^7 Btu/year

or a difference of 18.14×10^7 Btu/year

Thus in one case, yearly energy savings by subsidizing rail is .0018 trillion Btu's.

APPENDIX H

1974 Transportation Energy Use in Trilion Btu[14]

	Rail	Highway	Other Nonhighway Use of Motor Fuel	
Residual Oil	.277	----	----	
Distillate Oil	13.42	----	----	
Diesel and LPG	----	6.97	----	
Gasoline	----	52.0	4.0	
Electricity	.24	----	----	
	13.94	65.97	4.0	= 76.91

Vehicles @ 60 mph consume 5% more energy than at 55 mph.
Vehicles @ 65 mph consume 13% more energy than at 55 mph.
Vehicles @ 70 mph consume 20% more energy than at 55 mph.

Given 1974 Highway use of gas, diesel, and LPG of 66 trillion Btu's.

Growth rate average of 3% per year.[14]

1975	1976	1977	1978	1979	1980
67.9	69.9	72.0	74.2	76.4	78.7

75% of 1975 VMT were on roads with speed limits over 55 mph.

Assume 2/3 change behavior and maximum range

1976 Ave.

31.8% of VMT	55-60	15.9% would save 4.8%*	= .76% savings
19% of VMT	61-65	9.5% would save 11.5%	= 1.09% savings
7.7% of VMT	66-70	3.9% would save 17%	= .66% savings
3.8% of VMT	+70	1.9% would save 17%	= .32% savings
			2.83% savings

*Slightly lower when decreasing, because working from larger base to lower.

MONTANA HIGHWAY SPEED DATA

Data Source: Traffic Safety Division, Montana Department of Highways

Summer 1975

4,048 Cars Surveyed

Average Speed	55.8 mph
85th percentile	62.1 mph
Exceed 55 mph	52.6%
Exceed 60 mph	20.5%
Exceed 65 mph	6.8%
Exceed 70 mph	2.1%

Spring 1976

5,927 Cars Surveyed

Average Speed	57.2 mph
85th percentile	62.9 mph
Exceed 55 mph	62.3%
Exceed 60 mph	26.6%
Exceed 65 mph	9.0%
Exceed 70 mph	2.7%

Summer 1976

5,927 Cars Surveyed

Average Speed	58.1 mph
85th percentile	64.2 mph
Exceed 55 mph	68.0%
Exceed 60 mph	32%
Exceed 65 mph	11%
Exceed 70 mph	3.6%

MONTANA HIGHWAY SPEED DATA

Data Source -- Montana Highway Patrol - 10 Sites, 50 miles; straight, two lane highway, high accident rate, moving radar data collection

May 1976

24,562 Cars Surveyed

Average Speed	57.3 mph
85th percentile	64.7 mph
Exceed 55 mph	60.7%
Exceed 60 mph	32.5%
Exceed 65 mph	13.6%
Exceed 70 mph	4.7%

October 1976 -- After moving radar enforcement

27,608 Cars Surveyed

Average Speed	56.6 mph
85th percentile	64.1 mph
Exceed 55 mph	58.1%
Exceed 60 mph	30.7%
Exceed 65 mph	12.2%
Exceed 70 mph	4.2%

APPENDIX I

BIKEWAYS

The ratio of bicycles to autos in Miles City is about 42%. It is assumed for all cases that 40% of all auto trips may be potentially substitutable by bicycles. In addition, it is assumed that 2% of all trips are converted. Potential savings were determined by taking the average vehicle density per bicycle routes times the average bicycle trip of 6 miles roundtrip. This was factored times the number of work days per year and the potential and likely percent of trip substitutions.

Miles City

1975 population	11,000 people
4,000 bikes	9,512 motorized vehicles

Estimated Cost: $26,800

Funding Licence Program	3,500
Sale of Maps	1,250
Grant	22,050
	26,800

Maintenance of Bikeways -- by Miles City cost not determined -- about 6 miles routing

Assume that 40% could go to bicycles.

4000/9512 = 42%; and that 2% due = .8% of total miles traveled.

Assume 6 mile round trip/day -- 1969 average vehicles = 3,792 x 6 miles = 22,752 VMT/day.

Energy Savings

$$22{,}752 \frac{\text{miles}}{\text{day}} \times \frac{260 \text{ days}}{\text{year}} \times \frac{\text{gal.}}{13 \text{ miles}} \times \frac{125{,}000 \text{ Btu}}{\text{gal.}} \times 40\% \times 2\%$$

$3{,}640 \times 125{,}000 = 4.6 \times 10^{8} = .0004 \times 10^{12}$ @ 1975 = .0004 trillion Btu/year

MISSOULA

1974 - population 56,313

1972 - 18,000 bikes

1. Average weekly bicyclists

1st year	5,000
2nd year	6,000

Cost for bridge crossing and connects

Funded	Federal	State	Local	TOTAL
	176,820	44,180	920	117,000

(1976) $\frac{5{,}000 \text{ cars}}{\text{bike route crossing}} \times 6 \text{ miles} = 30{,}000$

Bikeways about 8 miles under development--assume 6 mile Rt.

$$30{,}000 \text{ miles/day} \times 260 \text{ days/year} \times \frac{\text{gal.}}{13 \text{ miles}} \times 125{,}000 \text{ Btu/gal.} \times 40\% \times 2\% =$$

$$6{,}000 \times 10^5 \text{ Btu/yr.} = .0006 \times 10^{12} \text{ Btu/year.}$$

BILLINGS

Route 7 miles 1st Stage Demonstration

Cost: $166,400/7 miles

Total number of vehicles registered 51,000.

Total number of bikes 37,000.

Average vehicle density on route 13,000 cars/day.

37,000/51,000 = 72.5% but conservatively use 40%.

13,000 cars/day x 6 mile Rt = 78,000 vehicle miles traveled.

$$78{,}000 \text{ VMT/day} \times 260 \text{ days/year} \times \frac{\text{gal.}}{13 \text{ miles}} \times 125{,}000 \text{ Btu} \times 40\% \times 2\% =$$

$15{,}600 \times 10^5$ Btu/year saved = $.0016 \times 10^{12}$ Btu/year.

GREAT FALLS

Survey 1975 - 6,982 persons by household representing 9.4% of total population.

5% of all bicycle trips are to work - therefore, 2% change is conservative.

46 mile route total at cost of $327,600 cost in 1976 dollars.

14.88 mile section to be completed by 1976-1980 $84,300 cost; therefore, @$16,000/year for 5 years.

Funding Source: 1) State allocation of 3/4 of 1% = $2,548 and with matching federal funds 74/26 = $9,785.

Other Potential Sources: Federal Revenue Sharing for bikeways, B.O.R., City General Funds, Highway Safety Funds.

@ 1/7 this year - $10,000 -

5,000 vehicles/day x 6 mile Rt = 30,000

$$30{,}000 \frac{\text{VMT}}{\text{day}} \times \frac{260 \text{ days}}{\text{year}} \times \frac{\text{gal.}}{13 \text{ miles}} \times \frac{125{,}000 \text{ Btu}}{\text{gal.}} \times 40\% \times 2\% =$$

$6{,}000 \times 10^5$ Btu/year

$.0006 \times 10^{12}$ Btu/year

Miles City	$.0004 \times 10^{12}$ Btu/year
Missoula	.0006
Billings	.0016
Great Falls	.0006

$.003200 \times 10^{12}$ Btu = $\frac{32000 \times 10^5}{1.2 \times 10^5}$ = 25,600 gal. gasoline

APPENDIX J

Net Fuel Savings

Program Measure	Pure Gas
Carpool	282,400 gal. gas/yr.
Gas Tax	12,024,000 gal. gas/yr.
55 Mph	17,840,000 gal. gas/yr.
Bikeways	25,600

30,172,000 gal. gas/yr. x 125,000 Btu = 3.77×10^{12} Btu/year.

	Gas	to	Diesel
Billings Bus	8.99×10^9 Btu/year (72,020 gal/yr)		2.26×10^9 Btu/year (18,250 gal/yr)
Missoula Bus	14.25×10^9 Btu/year (114,000 gal/yr)		7.767×10^9 Btu/year (55,958 gal/yr)

	Gas-Truck	Diesel-Rail
Freight	$.2639 \times 10^9$ Btu/yr	$.08246 \times 10^9$ Btu/yr
	(2111.2 gal gas/yr)	(594.1 gal diesel/year)

Crude Oil

2,725,123 gal. gas/yr or $.34 \times 10^{12}$ Btu/year

Combined Affect = $(4.11 + .00899 + .01425 + .00026) \times 10^{12}$ Btu/year reduced gas

$(.00226 + .007767 + .00008) \times 10^{12}$ Btu/year increase diesel

4.13×10^{12} reduced gas

= $.010 \times 10^{12}$ increased diesel

TOTAL 4.12×10^{12} Btu/year net fuel savings